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(54)【発明の名称】　半透膜の製造方法

(57)【要約】
【課題】廃棄すべきポリビニルピロリドンが最小限であり、かつ、紡糸性の優れた半透膜の製造方法を提供する。
【解決手段】ポリスルホン系樹脂と分子量の異なる2種類以上のポリビニルピロリドンとを主成分としてなる半透膜の製造方法において、製膜原液におけるポリスルホンに対するポリビニルピロリドンの重量比率が20%以上、35%以下であって、かつ、紡糸口金部温度－40℃≦ドライゾーンの温度≦紡糸口金部温度－15℃であり、さらに、相対湿度が60%以上、95%以下であることを特徴とする半透膜の製造方法。

【特許請求の範囲】
【請求項１】ポリスルホン系樹脂と平均分子量の異なる2種類以上のポリビニルピロリドンとを主成分としてなる半透膜の製造方法において、製膜原液におけるポリスルホンに対するポリビニルピロリドンの重量比率が20%以上、35%以下であって、かつ、紡糸口金部温度－40℃≦ドライゾーンの温度≦紡糸口金部温度－15℃であり、さらに、相対湿度が60%以上、95%以下であることを特徴とする半透膜の製造方法。
【請求項２】平均分子量が10万以上異なる2種類以上のポリビニルピロリドンを用いることを特徴とする請求項１記載の半透膜の製造方法。
【請求項３】該半透膜を人工腎臓用に用いることを特徴とする請求項１または２記載の半透膜の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、ポリスルホン系樹脂と平均分子量の異なる2種類以上のポリビニルピロリドンからなる半透膜の製造方法に関するものである。
【０００２】
【従来の技術】これまで慢性腎不全患者の血液処理膜を人腎レベルに近づけるために、様々な透析方法・膜の性能向上技術が開発されてきた。血液処理膜としては、例えばポリスルホンとともに、造孔剤としてポリビニルピロリドンを用いて製膜する方法が、特開平9-70524などにおいて知られている。このポリビニルピロリドンは、製膜時に造孔剤として用いられた後、その大半は洗い流され再利用されることがないため、その使用量を減らすことが好ましいが、特開平9-70524などにおいてはその使用量が多く、廃棄量が多いという問題点があった。
【０００３】また特開平4-338224では、製膜原液でのポリスルホン系樹脂に対するポリビニルピロリドンの混和比率を10重量%以下とすることが記載されている。しかしながら、この場合には、製膜原液粘度が低くなりすぎて、紡糸安定性に劣るという問題点があった。
【０００４】
【発明が解決しようとする課題】本発明は、上記従来技術の欠点を解消しようとするものであり、ポリビニルピロリドンの使用量が少なく、かつ、紡糸安定性に優れた半透膜の製造方法を提供することを目的とする。
【０００５】
【課題を解決するための手段】本発明は、上記課題を達成するために、下記の構成を有する。「ポリスルホン系樹脂と平均分子量の異なる2種類以上のポリビニルピロリドンとを主成分としてなる半透膜の製造方法において、製膜原液におけるポリスルホンに対するポリビニルピロリドンの重量比率が20%以上、35%以下であって、かつ、紡糸口金部温度－40℃≦ドライゾーンの温度≦紡糸口金部温度－15℃であり、さらに、相対湿度が60%以上、95%以下であることを特徴とする半透膜の製造方法。」
【０００６】
【発明の実施の形態】本発明のポリスルホン系樹脂としては、ポリスルホンが好ましいが、ベンゼン環部分を修飾したものも用いることができる。また、製膜原液におけるポリスルホン濃度としては、濃度を上げるに従って製膜性は良くなるが逆に膜における空孔率は減少し、透水性が低下する傾向がある。そのため、ポリスルホン濃度は、製膜原液中、10～30重量%であることが好ましく、さらには15～21重量%であることが好ましい。
【０００７】本発明においては、ポリビニルピロリドンとして平均分子量の異なる２種類以上のものを用いる。ここで、平均分子量が異なるとは、重量平均分子量が異なるものをいい、特に重量平均分子量で10万以上異なるものを用いることが好ましい。
【０００８】また一般に市販のポリスルホン系樹脂の分子量が低いことから、製膜原液の粘度は、ポリビニルピロリドンの分子量に依存する傾向がある。製膜原液粘度が低い場合、製膜時に糸切れ、糸揺れなどを起こし製糸安定性に劣る場合があるため、ポリビニルピロリドンの平均分子量は高いことが好ましく、４万以上が好ましい。
【０００９】製膜原液におけるポリビニルピロリドンの濃度は、上げるに従って粘度が上昇し製膜性が良くなるが、逆に廃棄すべきポリビニルピロリドンの量は増加する。そのため、製膜原液におけるポリビニルピロリドン濃度は2～20重量%が好ましく、さらには3～9重量%が好ましい。製膜された半透膜中ポリビニルピロリドンの含有率は、1～15wt%であることが好ましい。１wt%未満の場合、水濡れ性が不十分となり、血液と接触した際に凝固を引き起こす可能性がある。
【００１０】さらに、本発明の半透膜を人工腎臓として用いる場合、中高分子尿毒蛋白を選択的に透過し、アルブミン透過性を極力抑えることが好ましく、この点で製膜原液中の分子量10万以上のポリビニルピロリドンの混和比率が1.8～20重量%であることが好ましい。高すぎると原液粘度が上昇し、製膜困難となるだけではなく、透水性、拡散性能が低下する傾向がある。逆に低すぎる場合、中高分子尿毒蛋白を透過させるための適当な孔を有する膜構造が形成できなくなる傾向がある。
【００１１】製膜原液においては、ポリスルホン系樹脂およびポリビニルピロリドンの良溶媒が用いられる。具体的には、ジメチルアセトアミド、ジメチルホルムアミド、ジメチルスルオキシド、アセトン、アセトアルデヒド、2-メチルピロリドンなどであるが、危険性、安全性、毒性の面からジメチルアセトアミドが好ましい。
【００１２】製膜原液には、さらに、ポリスルホンの貧溶媒で、かつ、ポリビニルピロリドンと相溶性を持つ添加剤が用いられる。具体的には、アルコール、グリセリン、水、エステル類などであるが、プロセス適性の面か

ら特に水が好ましい。

【００１３】本発明の半透膜は、中空糸膜、平膜、繊維状膜等として好適に用いられる。中空糸膜として用いる場合の製膜方法は、以下のとおりである。

【００１４】まず、製膜原液と、芯液とを、同時に二重スリット管構造の口金から同時にドライゾーンに吐出させる。この時のドライゾーンの雰囲気を特定の条件に保つことで、季節変動による性能の変化を抑制することができる。すなわち、ドライゾーン温度、相対湿度が高すぎると中空糸膜内部において相分離が起こる前に外表面は凝固し、緻密層ができる。また、ドライゾーン温度、相対湿度が低すぎると相分離する前に水中に浸漬されるため外表面は相分離する前に凝固し、緻密層ができる。ゆえにドライゾーン温度は、紡糸口金部温度－40℃≦ドライゾーンの温度≦紡糸口金部温度－15℃紡糸口金部温度の条件を満たすことが必要である。また、相対湿度は、60%以上、95%以下であることが必要である。

【００１５】ここで、相対湿度とは、水蒸気圧と飽和水蒸気圧の比を%で表したものをいう。

【００１６】上記条件により紡糸した後、所定の水洗、保湿工程を経た後、巻き取られ、モジュール化される。巻き取られた中空糸膜は人工腎臓用に用いる場合、このままではポリビニルピロリドンの溶出が多く、人工臓器基準に記載された数値を満たさない傾向があるため、γ線、電子線、熱、化学的処理などにより架橋し、溶出物を低減させることが好ましい。架橋処理により、ポリスルホンとポリビニルピロリドンが結合することでポリビニルピロリドンの溶出が減少する。さらにポリビニルピロリドンの溶出を防ぐためには、γ線照射前に、脱気膜を通過した水でモジュールを洗浄することが好ましい。γ線照射は、水充填でのγ線照射が好ましく、照射量は10～50KGy、さらには20～40KGyが好ましい。これらの方法で作成された人工腎臓は、尿毒物質の拡散、有用蛋白であるアルブミンの阻止などの性能に優れ、かつ、ポリビニルピロリドンの溶出が少ない。

【００１７】本発明により得られる半透膜は、例えば、透析器、血漿分離器等の血液浄化膜、限外濾過膜などとして、好適に用いられる。

【００１８】

【実施例】次に実施例に基づき本発明を説明する。

【００１９】用いた測定方法は以下の通りである。

(1) 原液粘度の測定

東機産業製Ｂ型回転粘度計Ｂ８タイプを用いて測定を行った。温度制御装置付きシリコンオイルバスに原液の入ったサンプルビンを入れ、温度を所定温度にして、５点測定した。

(2) 透水性能の測定

中空糸両端部を封止したモジュール（面積　1.3m^2）の中空糸内側に水圧100mmHgをかけ、外側に流出してくる単位時間当たりの濾過量を測定した。透水性能は下記の式で算出した。

【００２０】

透水性能（ml/hr/m^2/mmHg）＝QW/（T・A・P）

ここで、QWは濾過量（ml/min）、Tは流出時間（hr）、Pは圧力（mmHg）、Aは膜面積（m^2）（中空糸内表面積換算）を意味する。

(3) アルブミン透過率の測定

血液槽に温度37℃で保温したヘマトクリット値30%、総蛋白量6.0g/dl（エチレンジアミン四酢酸（EDTA）処理血液）に調製した牛血液を中空糸両端部を封止したモジュール（面積　1.3m^2）の中空糸内側に200ml/minで灌流させ、40ml/minの濾過流量で濾過をした。この時、濾液、出口血液は血液槽に戻した。

【００２１】灌流開始1時間後にモジュール入り口、モジュール出口の血液、濾液をサンプリングし、血液側をBCG（ブロムクレゾールグリーン）法（和光純薬）によって分析し、その濃度からアルブミン透過率を算出した。

【００２２】

アルブミン透過率（%）＝{2×Cf/(CBi+CBo)}×100

ここで、Cfは濾液中、CBiはモジュール入り口、CBoはモジュール出口のアルブミン濃度を示す。

(4) 元素分析法によるポリビニルピロリドンの含有率の測定

γ線照射後のサンプルを常温、真空ポンプで乾固させ、その10mgをCHNコーダーで分析し、窒素含有率からポリスルホンに対するポリビニルピロリドンの含有率を計算した。

実施例１

以下実施例において、「部」は「重量部」を意味する。

【００２３】ポリスルホン（アモコ社　Udel-P3500）18部、ポリビニルピロリドン（BASFK90 重量平均分子量１２０万）3部、ポリビニルピロリドン（BASF K30　重量平均分子量４万）3部をジメチルアセトアミド75部、水1部に加え、加熱溶解した。原液粘度は、50℃で23ポイズであった。この原液を温度50℃の紡糸口金部へ送り、外径0.35mm、内径0.25mmの2重スリット管から芯液としてジメチルアセトアミド58部からなる溶液を吐出させ、内径200μmの膜厚40μmの中空糸膜を形成させた後、温度30℃、相対湿度93%（testoterm社製　testo452）の350mmのドライゾーンを通過させ、80℃の水洗工程、グリセリンによる保湿工程を経て得られた中空糸膜を巻き取り束とした。この中空糸膜を1.3m^{2}になるようにケースに充填し、ポッティングしてモジュールとした。モジュール化後、脱気された温水（37℃）で、まず血液側を毎分200ml/minで1時間洗浄し、血液側を止め、次に血液透析側を同様に洗浄し、最後に血液側から透析液側へ膜を透過させて同様に洗浄した。水充填のままγ線照射後（32KGy）、透水性能、アルブミン透過率を測定したところ透水性能　1109ml/hr/m^2/mmHg、アルブミン透過率0.76%

であった。

【００２４】また、最終的な膜内のポリスルホンに対するポリビニルピロリドン含有率は4.1重量%であった。この場合、製膜原液を100kg（PVP 6kg含有）用いると、最終的に膜中にはPVPが0.74kg残り、5.26kgを廃棄することになる。

実施例２

ポリスルホン（アモコ社　Udel-P3500）17部、ポリビニルピロリドン（BASFK90）3部、ポリビニルピロリドン（BASF K30）1部をジメチルアセトアミド78部、水1部に加え、加熱溶解した。原液粘度は50℃で14.5ポイズであった。この原液を、ジメチルアセトアミド58部からなる芯液を用いて、実施例1と同じ工程で製膜し、モジュールを作成した。透水性能　1380ml/hr/m^2/mmHg、アルブミン透過率1.12%であった。また、最終的な膜内のポリスルホンに対するポリビニルピロリドン含有率は3.8重量%であった。この場合、製膜原液を100kg（PVP 4kg含有）用いると、最終的に膜中にはPVPが0.65kg残り、3.35kgを廃棄することになる。

比較例１

ポリスルホン（アモコ社　Udel-P3500）18部、ポリビニルピロリドン（BASFK90）4部、ポリビニルピロリドン（BASF K30）5部をジメチルアセトアミド72部、水1部を加え、加熱溶解した。原液粘度は50℃で45ポイズであった。この原液を、ジメチルアセトアミド60部からなる芯液を用いて、実施例1と同じ工程で製膜し、モジュールを作成した。透水性能　662ml/hr/m^2/mmHg、アルブミン透過率0.23%であった。しかし、最終的な膜内のポリスルホンに対するポリビニルピロリドン含有率は7.8重量%であった。この場合、製膜原液を100kg（PVP 9kg含有）用いると、最終的に中空糸膜中にはPVPが1.40kg残り、7.6kgを廃棄することになり、廃棄量が多くなった。

比較例２

ポリスルホン（アモコ社　Udel-P3500）18部、ポリビニルピロリドン（BASFK90）1.8部をジメチルアセトアミド78部、水1部を加え、加熱溶解した。原液粘度は50℃で9.0ポイズであった。この原液を、ジメチルアセトアミド60部からなる芯液を用いて、実施例1と同じ工程で製膜し、モジュールを作成した。透水性能は1054ml/hr/m^2/mmHg、アルブミン透過率は2%以上の非常に高い値を示した。

比較例３

実施例1と同じ原液、芯液を用いて中空糸膜を吐出し、温度40℃、相対湿度100%の350mmのドライゾーンを通過させ製膜したが、ポリスルホン外表面に緻密層ができた。

比較例４

実施例1と同じ原液、芯液を用いて中空糸膜を吐出し、温度5℃、相対湿度100%の350mmのドライゾーンを通過させ製膜したが、ポリスルホン外表面に緻密層ができた。

比較例５

実施例1と同じ原液、芯液を用いて中空糸膜を吐出し、温度30℃、相対湿度50%の350mmのドライゾーンを通過させ製膜したが、ポリスルホン外表面に緻密層ができた。

【００２５】

【発明の効果】本発明により、廃棄すべきポリビニルピロリドンが最小限であり、かつ、紡糸性の優れた半透膜の製造方法を提供することができた。

I. PATENT ABSTRACTS OF JAPAN

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(71)Applicant : **TORAY IND INC**
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(54) **PRODUCTION OF SEMIPERMEABLE MEMBRANE**

(57)Abstract:
PROBLEM TO BE SOLVED: To produce a semipermeable membrane minimized in the amt. of polyvinyl pyrrolidone to be discarded and excellent in spinning properties.
SOLUTION: In a method for producing a semipermeable membrane based on a polysulfone resin and two or more kinds of polyvinyl pyrrolidone resins different in mol.wt., the wt. ratio of the polyvinyl pyrrolidone resins to polysulfone in a membrane forming raw soln. is 20-35% and the temp. of a dry zone is spinning cap portion temp. -40°C ≤ temp. of dry zone ≤ spinning cap portion temp. -15°C and relative humidity is 60-95%.

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CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the semipermeable membrane characterized by for the weight ratios of the polyvinyl pyrrolidone to the polysulfone in a film production undiluted solution being 20% or more and 35% or less, and being -15 degrees C in temperature <= spinneret section temperature of a spinneret section temperature [of -40 degrees C] <= dry zone in the manufacture approach of the semipermeable membrane which becomes considering two or more kinds of polyvinyl pyrrolidones from which polysulfone system resin and a mean molecular weight differ as a principal component, and relative humidity being 60% or more and 95% or less further.
[Claim 2] The manufacture approach of the semipermeable membrane according to claim 1 characterized by using two or more kinds of polyvinyl pyrrolidones from which a mean molecular weight differs 100,000 or more.
[Claim 3] The manufacture approach of the semipermeable membrane according to claim 1 or 2 characterized by using this semipermeable membrane for artificial kidneys.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the semipermeable membrane which consists of two or more kinds of polyvinyl pyrrolidones from which polysulfone system resin and a mean molecular weight differ.
[0002]
[Description of the Prior Art] In order to bring a chronic-renal-failure patient's blood processing film close to **** level, the improvement technique in the engine performance of various dialysis approach and film has so far been developed. As blood processing film, the approach of producing a film with polysulfone, using a polyvinyl pyrrolidone as an ostomy agent is learned in JP,9-70524,A etc., for example. Although it was desirable to have reduced that amount used since that most was flushed and was not reused after this polyvinyl pyrrolidone was used as an ostomy agent at the time of film production, there was much that amount used in JP,9-70524,A etc., and there was a trouble that there were many amounts of abolition.
[0003] Moreover, making the mixing ratio of the polyvinyl pyrrolidone to the polysulfone system resin in a film production undiluted solution into 10 or less % of the weight is indicated by JP,4-338224,A. However, in this case, film production undiluted solution viscosity became low too much, and there was a trouble of being inferior to spinning stability.
[0004]

[Problem(s) to be Solved by the Invention] This invention tends to cancel the fault of the above-mentioned conventional technique, and there is little amount of the polyvinyl pyrrolidone used, and it aims at offering the manufacture approach of semipermeable membrane excellent in spinning stability.

[0005]

[Means for Solving the Problem] This invention has the following configuration, in order to attain the above-mentioned technical problem. "The manufacture approach of the semipermeable membrane characterized by for the weight ratios of the polyvinyl pyrrolidone to the polysulfone in a film production undiluted solution being 20% or more and 35% or less, and being -15 degrees C in temperature <= spinneret section temperature of a spinneret section temperature [of -40 degrees C] <= dry zone in the manufacture approach of the semipermeable membrane which become considering two or more kinds of polyvinyl pyrrolidones from which polysulfone system resin and a mean molecular weight differ as a principal component, and relative humidity being 60% or more and 95% or less further."

[0006]

[Embodiment of the Invention] As polysulfone system resin of this invention, although polysulfone is desirable, what embellished the benzene ring part can be used. Moreover, although film production nature becomes good as polysulfone concentration in a film production undiluted solution as concentration is raised, the void content in the film decreases and the inclination for water permeability to fall is in reverse. Therefore, among a film production undiluted solution, as for polysulfone concentration, it is desirable that it is 10 - 30 % of the weight, and it is desirable that it is further 15 - 21 % of the weight.

[0007] In this invention, two or more kinds of things from which average molecular weight differs as a polyvinyl pyrrolidone are used. It is desirable to use what says that from which weight average molecular weight differs that average molecular weight differs here, and is different 100,000 or more with especially weight average molecular weight.

[0008] Moreover, since the molecular weight of commercial polysulfone system resin is generally low, it tends to depend for the viscosity of a film production undiluted solution on the molecular weight of a polyvinyl pyrrolidone. Since it may be inferior to lifting silk manufacture stability in the thread breakage, a yarn shake, etc. at the time of film production when film production undiluted solution viscosity is low, the high thing of the average molecular weight of a polyvinyl pyrrolidone is desirable, and 40,000 or more are desirable.

[0009] Although viscosity rises and film production nature becomes good as the concentration of the polyvinyl pyrrolidone in a film production undiluted solution is raised, the amount of the polyvinyl pyrrolidone which should be discarded conversely increases. Therefore, the polyvinyl-pyrrolidone concentration in a film production undiluted solution has 2 - 20 desirable % of the weight, and its further 3 - 9 % of the weight is desirable. As for the content of the produced polyvinyl pyrrolidone in semipermeable membrane, it is desirable that it is 1 - 15wt%. In the case of below 1wt%, water wettability becomes inadequate, and coagulation may be caused when blood is contacted.

[0010] furthermore, the case where the semipermeable membrane of this invention is used as an artificial kidney -- the crown -- it is desirable to penetrate molecule **** protein selectively and to suppress albumin permeability as much as possible, and it is desirable that the mixing ratio of a with a molecular weight [in a film production undiluted solution] of 100,000 or more polyvinyl pyrrolidone is 1.8 - 20 % of the weight at this point. If too high, undiluted solution viscosity will rise, and there is an inclination it not only to become difficult to produce a film, but

for water permeability and diffusibility ability to fall. Conversely, when too low, there is an inclination it becomes impossible to form the membrane structure which has a suitable hole for making inside macromolecule **** protein penetrate.
[0011] In a film production undiluted solution, the good solvent of polysulfone system resin and a polyvinyl pyrrolidone is used. Although it is dimethylacetamide, dimethylformamide, dimethyl suloxide, an acetone, an acetaldehyde, 2-methyl pyrrolidone, etc., specifically, a toxic field to danger, safety, and dimethylacetamide are desirable.
[0012] The additive which is the poor solvent of polysulfone and has a polyvinyl pyrrolidone and compatibility further is used for a film production undiluted solution. Although it is alcohol, a glycerol, water, and ester, specifically, water is desirable especially from the field of process fitness.
[0013] The semipermeable membrane of this invention is suitably used as a hollow fiber, a flat film, fibrous film, etc. The film production approach in the case of using as a hollow fiber is as follows.
[0014] First, a dry zone is made to breathe out a film production undiluted solution and core liquid simultaneously from the mouthpiece of duplex slit tubing structure. By maintaining the ambient atmosphere of the dry zone at this time at specific conditions, change of the engine performance by the seasonal variation can be controlled. That is, if dry zone temperature and relative humidity are too high, before phase separation will happen in the interior of a hollow fiber, an outside surface solidifies and can do a compact layer. Moreover, since it is underwater immersed before carrying out phase separation, if dry zone temperature and relative humidity are too low, before carrying out phase separation of the outside surface, it is solidified, and can do a compact layer. Therefore, dry zone temperature needs to fulfill the conditions of the temperature <= spinneret section temperature spinneret section temperature of -15 degrees C of a spinneret section temperature [of -40 degrees C] <= dry zone. Moreover, relative humidity needs to be 60% or more and 95% or less.
[0015] Here, relative humidity means what expressed the ratio of a water vapor pressure and saturated water vapor pressure with %.
[0016] A modularization is rolled round and carried out, after carrying out spinning according to the above-mentioned conditions and passing through predetermined rinsing and a moisturization process. When using for artificial kidneys, as for the rolled-round hollow fiber, it is desirable for there to be much elution of a polyvinyl pyrrolidone, to construct a bridge by the gamma ray, the electron ray, heat, chemical preparation, etc., since there is an inclination not to fulfill the numeric value indicated by artificial organ criteria, and to reduce an effluent the way things stand. By bridge formation processing, elution of a polyvinyl pyrrolidone decreases because polysulfone and a polyvinyl pyrrolidone join together. In order to prevent elution of a polyvinyl pyrrolidone furthermore, it is desirable to wash a module with the water which passed the deaeration film before gamma irradiation. The gamma irradiation of gamma irradiation in water restoration is desirable, and 20-40KGy of a dose is desirable to 10 - 50KGy and a pan. The artificial kidney created by these approaches is excellent in engine performance, such as diffusion of urine poison, and inhibition of the albumin which is useful protein, and there is little elution of a polyvinyl pyrrolidone.
[0017] The semipermeable membrane obtained by this invention is suitably used as blood purification film, such as a dialyzer and a plasma eliminator, ultrafiltration membrane, etc.
[0018]
[Example] Next, this invention is explained based on an example.

[0019] The used measuring method is as follows.
(1) It measured using B mold rotational-viscometer B8 made from measurement east machine industry type of undiluted solution viscosity. The sample bottle by which the undiluted solution went into the silicon oil bath with a temperature controller was put in, and temperature was made into predetermined temperature and measured five points.
(2) Water pressure 100mmHg was applied inside [hollow filament] the module (area 1.3m2) which closed the measurement hollow filament both ends of permeable ability, and the amount of filtration per [which flows out outside] unit time amount was measured. Permeable ability was computed by the following formula.
[0020]
Permeable ability (ml/hr/m2/mmHg) = QW/(T-A-P)
Here, in QW, runoff time amount (hr) and P mean a pressure (mmHg), and, as for A, the amount (ml/min) of filtration and T mean a film surface product (m2) (hollow filament internal-surface product conversion).
(3) Perfusion of the bovine blood liquid prepared to 30% of hematocrit values and amount of total protein 6.0 g/dl (ethylenediaminetetraacetic acid (EDTA) processing blood) which kept it warm at the temperature of 37 degrees C to the measurement blood tub of albumin permeability was carried out by 200 ml/min inside [hollow filament] the module (area 1.3m2) which closed hollow filament both ends, and it filtered by the filtration flow rate of 40 ml/min. At this time, filtrate and outlet blood were returned to the blood tub.
[0021] 1 hour after rotary flow initiation -- the blood of a module entry and a module outlet, and filtrate -- sampling -- a blood side -- BCG (bromcresol green) -- it analyzed by law (Wako Pure Chem), and albumin permeability was computed from the concentration.
[0022]
albumin permeability (%) ={2xCf/(CBi+CBo)} x100 -- here, in Cf, CBi shows a module entry among filtrate and CBo shows the albumin concentration of a module outlet.
(4) The sample after the measurement gamma irradiation of the content of the polyvinyl pyrrolidone by the ultimate analysis method was made to harden by drying with ordinary temperature and a vacuum pump, the CHN coder analyzed the 10mg, and the content of the polyvinyl pyrrolidone to polysulfone was calculated from nitrogen content.
In an one or less example example, the "section" means the "weight section."
[0023] The polysulfone (Amoco Corp. Udel-P3500) 18 section, the polyvinyl-pyrrolidone (BASFK90 weight average molecular weight 1,200,000) 3 section, and the polyvinyl-pyrrolidone (BASF K30 weight average molecular weight 40,000) 3 section were added to the dimethylacetamide 75 section and the water 1 section, and the heating dissolution was carried out. Undiluted solution viscosity was 23poise at 50 degrees C. The solution which consists this undiluted solution of the dimethylacetamide 58 section to the spinneret section with a temperature of 50 degrees C as core liquid from double slit tubing with delivery, an outer diameter [of 0.35mm], and a bore of 0.25mm is made to breathe out. The temperature of 30 degrees C after making the hollow fiber of 40 micrometers of bore thickness of 200 micrometers form, The 350mm dry zone of 93% of relative humidity (testo452 made from testoterm) was passed, the hollow fiber pass the 80-degree C rinsing process and the moisturization process by the glycerol was rolled round, and it considered as the bundle. Potting of this hollow fiber was filled up with and carried out to the case so that it might be set to 2 1.3m, and it considered as the module. After the modularization, with the deaerated warm water (37 degrees C), the blood side was first washed by per minute 200 ml/min for 1 hour, and the hemodialysis side was similarly

washed for the blood side to the stop and the degree, and finally, the film was made to penetrate and it washed from the blood side similarly to the dialysing fluid side. It is permeable ability when permeable ability and albumin transmission were measured after gamma irradiation (32KGy) with water restoration. They were 1109 ml/hr/m2/mmHg and 0.76% of albumin transmission.

[0024] Moreover, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 4.1 % of the weight. In this case, when 100kg (PVP 6kg content) of film production undiluted solutions is used, into the film, 0.74kg of PVP will remain eventually, and 5.26kg will be discarded.

The example 2 polysulfone (Amoco Corp. Udel-P3500) 17 section, the polyvinyl-pyrrolidone (BASFK90) 3 section, and the polyvinyl-pyrrolidone (BASF K30) 1 section were added to the dimethylacetamide 78 section and the water 1 section, and the heating dissolution was carried out. Undiluted solution viscosity was 14.5poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 58 section, and the module was created. Permeable ability They were 1380 ml/hr/m2/mmHg and 1.12% of albumin permeability. Moreover, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 3.8 % of the weight. In this case, when 100kg (PVP 4kg content) of film production undiluted solutions is used, into the film, 0.65kg of PVP will remain eventually, and 3.35kg will be discarded.

The dimethylacetamide 72 section and the water 1 section were added, and the heating dissolution of the example of comparison 1 polysulfone (Amoco Corp. Udel-P3500) 18 section, the polyvinyl-pyrrolidone (BASFK90) 4 section, and the polyvinyl-pyrrolidone (BASF K30) 5 section was carried out. Undiluted solution viscosity was 45poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 60 section, and the module was created. Permeable ability They were 662 ml/hr/m2/mmHg and 0.23% of albumin permeability. However, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 7.8 % of the weight. In this case, when 100kg (PVP 9kg content) of film production undiluted solutions was used, into a hollow fiber, 1.40kg of PVP will remain eventually, 7.6kg will be discarded, and the amount of abolition increased.

The dimethylacetamide 78 section and the water 1 section were added, and the heating dissolution of the example of comparison 2 polysulfone (Amoco Corp. Udel-P3500) 18 section and the polyvinyl-pyrrolidone (BASFK90) 1.8 section was carried out. Undiluted solution viscosity was 9.0poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 60 section, and the module was created. As for 1054 ml/hr/m2/mmHg and albumin permeability, permeable ability showed 2% or more of very high value.

Although the 350mm dry zone of discharge, the temperature of 40 degrees C, and 100% of relative humidity was passed and the hollow fiber was produced using the same undiluted solution as example of comparison 3 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.

Although the 350mm dry zone of discharge, the temperature of 5 degrees C, and 100% of relative humidity was passed and the hollow fiber was produced using the same undiluted solution as example of comparison 4 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.

Although the 350mm dry zone of discharge, the temperature of 30 degrees C, and 50% of relative humidity was passed and the hollow fiber was produced using the same undiluted

solution as example of comparison 5 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.
[0025]
[Effect of the Invention] The manufacture approach of semipermeable membrane that the polyvinyl pyrrolidone which should be discarded was the minimum and spinning nature was excellent with this invention was able to be offered.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacture approach of the semipermeable membrane which consists of two or more kinds of polyvinyl pyrrolidones from which polysulfone system resin and a mean molecular weight differ.

PRIOR ART

[Description of the Prior Art] In order to bring a chronic-renal-failure patient's blood processing film close to **** level, the improvement technique in the engine performance of various dialysis approach and film has so far been developed. As blood processing film, the approach of producing a film with polysulfone, using a polyvinyl pyrrolidone as an ostomy agent is learned in JP,9-70524,A etc., for example. Although it was desirable to have reduced that amount used since that most was flushed and was not reused after this polyvinyl pyrrolidone was used as an ostomy agent at the time of film production, there was much that amount used in JP,9-70524,A etc., and there was a trouble that there were many amounts of abolition.
[0003] Moreover, making the mixing ratio of the polyvinyl pyrrolidone to the polysulfone system resin in a film production undiluted solution into 10 or less % of the weight is indicated by JP,4-338224,A. However, in this case, film production undiluted solution viscosity became low too much, and there was a trouble of being inferior to spinning stability.

EFFECT OF THE INVENTION

[Effect of the Invention] The manufacture approach of semipermeable membrane that the polyvinyl pyrrolidone which should be discarded was the minimum and spinning nature was excellent with this invention was able to be offered.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention tends to cancel the fault of the above-mentioned conventional technique, and there is little amount of the polyvinyl pyrrolidone used, and it aims at offering the manufacture approach of semipermeable membrane excellent in spinning stability.

MEANS

[Means for Solving the Problem] This invention has the following configuration, in order to attain the above-mentioned technical problem. "The manufacture approach of the semipermeable membrane characterized by for the weight ratios of the polyvinyl pyrrolidone to the polysulfone in a film production undiluted solution being 20% or more and 35% or less, and being -15 degrees C in temperature <= spinneret section temperature of a spinneret section temperature [of -40 degrees C] <= dry zone in the manufacture approach of the semipermeable membrane which become considering two or more kinds of polyvinyl pyrrolidones from which polysulfone system resin and a mean molecular weight differ as a principal component, and relative humidity being 60% or more and 95% or less further."

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[Embodiment of the Invention] As polysulfone system resin of this invention, although polysulfone is desirable, what embellished the benzene ring part can be used. Moreover, although film production nature becomes good as polysulfone concentration in a film production undiluted solution as concentration is raised, the void content in the film decreases and the inclination for water permeability to fall is in reverse. Therefore, among a film production undiluted solution, as for polysulfone concentration, it is desirable that it is 10 - 30 % of the weight, and it is desirable that it is further 15 - 21 % of the weight.

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[0008] Moreover, since the molecular weight of commercial polysulfone system resin is generally low, it tends to depend for the viscosity of a film production undiluted solution on the molecular weight of a polyvinyl pyrrolidone. Since it may be inferior to lifting silk manufacture stability in the thread breakage, a yarn shake, etc. at the time of film production when film production undiluted solution viscosity is low, the high thing of the average molecular weight of a polyvinyl pyrrolidone is desirable, and 40,000 or more are desirable.

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[0010] furthermore, the case where the semipermeable membrane of this invention is used as an artificial kidney -- the crown -- it is desirable to penetrate molecule **** protein selectively and to suppress albumin permeability as much as possible, and it is desirable that the mixing ratio of a with a molecular weight [in a film production undiluted solution] of 100,000 or more polyvinyl pyrrolidone is 1.8 - 20 % of the weight at this point. If too high, undiluted solution viscosity will rise, and there is an inclination it not only to become difficult to produce a film, but for water permeability and diffusibility ability to fall. Conversely, when too low, there is an inclination it becomes impossible to form the membrane structure which has a suitable hole for

making inside macromolecule **** protein penetrate.
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[0012] The additive which is the poor solvent of polysulfone and has a polyvinyl pyrrolidone and compatibility further is used for a film production undiluted solution. Although it is alcohol, a glycerol, water, and ester, specifically, water is desirable especially from the field of process fitness.
[0013] The semipermeable membrane of this invention is suitably used as a hollow fiber, a flat film, fibrous film, etc. The film production approach in the case of using as a hollow fiber is as follows.
[0014] First, a dry zone is made to breathe out a film production undiluted solution and core liquid simultaneously from the mouthpiece of duplex slit tubing structure. By maintaining the ambient atmosphere of the dry zone at this time at specific conditions, change of the engine performance by the seasonal variation can be controlled. That is, if dry zone temperature and relative humidity are too high, before phase separation will happen in the interior of a hollow fiber, an outside surface solidifies and can do a compact layer. Moreover, since it is underwater immersed before carrying out phase separation, if dry zone temperature and relative humidity are too low, before carrying out phase separation of the outside surface, it is solidified, and can do a compact layer. Therefore, dry zone temperature needs to fulfill the conditions of the temperature <= spinneret section temperature spinneret section temperature of -15 degrees C of a spinneret section temperature [of -40 degrees C] <= dry zone. Moreover, relative humidity needs to be 60% or more and 95% or less.
[0015] Here, relative humidity means what expressed the ratio of a water vapor pressure and saturated water vapor pressure with %.
[0016] A modularization is rolled round and carried out, after carrying out spinning according to the above-mentioned conditions and passing through predetermined rinsing and a moisturization process. When using for artificial kidneys, as for the rolled-round hollow fiber, it is desirable for there to be much elution of a polyvinyl pyrrolidone, to construct a bridge by the gamma ray, the electron ray, heat, chemical preparation, etc., since there is an inclination not to fulfill the numeric value indicated by artificial organ criteria, and to reduce an effluent the way things stand. By bridge formation processing, elution of a polyvinyl pyrrolidone decreases because polysulfone and a polyvinyl pyrrolidone join together. In order to prevent elution of a polyvinyl pyrrolidone furthermore, it is desirable to wash a module with the water which passed the deaeration film before gamma irradiation. The gamma irradiation of gamma irradiation in water restoration is desirable, and 20-40KGy of a dose is desirable to 10 - 50KGy and a pan. The artificial kidney created by these approaches is excellent in engine performance, such as diffusion of urine poison, and inhibition of the albumin which is useful protein, and there is little elution of a polyvinyl pyrrolidone.
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EXAMPLE

[Example] Next, this invention is explained based on an example.
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(2) Water pressure 100mmHg was applied inside [hollow filament] the module (area 1.3m2) which closed the measurement hollow filament both ends of permeable ability, and the amount of filtration per [which flows out outside] unit time amount was measured. Permeable ability was computed by the following formula.
[0020]
Permeable ability (ml/hr/m2/mmHg) = QW/(T-A-P)
Here, in QW, runoff time amount (hr) and P mean a pressure (mmHg), and, as for A, the amount (ml/min) of filtration and T mean a film surface product (m2) (hollow filament internal-surface product conversion).
(3) Perfusion of the bovine blood liquid prepared to 30% of hematocrit values and amount of total protein 6.0 g/dl (ethylenediaminetetraacetic acid (EDTA) processing blood) which kept it warm at the temperature of 37 degrees C to the measurement blood tub of albumin permeability was carried out by 200 ml/min inside [hollow filament] the module (area 1.3m2) which closed hollow filament both ends, and it filtered by the filtration flow rate of 40 ml/min. At this time, filtrate and outlet blood were returned to the blood tub.
[0021] 1 hour after rotary flow initiation -- the blood of a module entry and a module outlet, and filtrate -- sampling -- a blood side -- BCG (bromcresol green) -- it analyzed by law (Wako Pure Chem), and albumin permeability was computed from the concentration.
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albumin permeability (%) ={2xCf/(CBi+CBo)} x100 -- here, in Cf, CBi shows a module entry among filtrate and CBo shows the albumin concentration of a module outlet.
(4) The sample after the measurement gamma irradiation of the content of the polyvinyl pyrrolidone by the ultimate analysis method was made to harden by drying with ordinary temperature and a vacuum pump, the CHN coder analyzed the 10mg, and the content of the polyvinyl pyrrolidone to polysulfone was calculated from nitrogen content.
In an one or less example example, the "section" means the "weight section."
[0023] The polysulfone (Amoco Corp. Udel-P3500) 18 section, the polyvinyl-pyrrolidone (BASFK90 weight average molecular weight 1,200,000) 3 section, and the polyvinyl-pyrrolidone (BASF K30 weight average molecular weight 40,000) 3 section were added to the dimethylacetamide 75 section and the water 1 section, and the heating dissolution was carried out. Undiluted solution viscosity was 23poise at 50 degrees C. The solution which consists this undiluted solution of the dimethylacetamide 58 section to the spinneret section with a temperature of 50 degrees C as core liquid from double slit tubing with delivery, an outer diameter [of 0.35mm], and a bore of 0.25mm is made to breathe out. The temperature of 30 degrees C after making the hollow fiber of 40 micrometers of bore thickness of 200 micrometers form, The 350mm dry zone of 93% of relative humidity (testo452 made from testoterm) was passed, the hollow fiber pass the 80-degree C rinsing process and the moisturization process by

the glycerol was rolled round, and it considered as the bundle. Potting of this hollow fiber was filled up with and carried out to the case so that it might be set to 2 1.3m, and it considered as the module. After the modularization, with the deaerated warm water (37 degrees C), the blood side was first washed by per minute 200 ml/min for 1 hour, and the hemodialysis side was similarly washed for the blood side to the stop and the degree, and finally, the film was made to penetrate and it washed from the blood side similarly to the dialysing fluid side. It is permeable ability when permeable ability and albumin transmission were measured after gamma irradiation (32KGy) with water restoration. They were 1109 ml/hr/m2/mmHg and 0.76% of albumin transmission.

[0024] Moreover, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 4.1 % of the weight. In this case, when 100kg (PVP 6kg content) of film production undiluted solutions is used, into the film, 0.74kg of PVP will remain eventually, and 5.26kg will be discarded.

The example 2 polysulfone (Amoco Corp. Udel-P3500) 17 section, the polyvinyl-pyrrolidone (BASFK90) 3 section, and the polyvinyl-pyrrolidone (BASF K30) 1 section were added to the dimethylacetamide 78 section and the water 1 section, and the heating dissolution was carried out. Undiluted solution viscosity was 14.5poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 58 section, and the module was created. Permeable ability They were 1380 ml/hr/m2/mmHg and 1.12% of albumin permeability. Moreover, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 3.8 % of the weight. In this case, when 100kg (PVP 4kg content) of film production undiluted solutions is used, into the film, 0.65kg of PVP will remain eventually, and 3.35kg will be discarded.

The dimethylacetamide 72 section and the water 1 section were added, and the heating dissolution of the example of comparison 1 polysulfone (Amoco Corp. Udel-P3500) 18 section, the polyvinyl-pyrrolidone (BASFK90) 4 section, and the polyvinyl-pyrrolidone (BASF K30) 5 section was carried out. Undiluted solution viscosity was 45poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 60 section, and the module was created. Permeable ability They were 662 ml/hr/m2/mmHg and 0.23% of albumin permeability. However, the polyvinyl-pyrrolidone content to the polysulfone in the final film was 7.8 % of the weight. In this case, when 100kg (PVP 9kg content) of film production undiluted solutions was used, into a hollow fiber, 1.40kg of PVP will remain eventually, 7.6kg will be discarded, and the amount of abolition increased.

The dimethylacetamide 78 section and the water 1 section were added, and the heating dissolution of the example of comparison 2 polysulfone (Amoco Corp. Udel-P3500) 18 section and the polyvinyl-pyrrolidone (BASFK90) 1.8 section was carried out. Undiluted solution viscosity was 9.0poise at 50 degrees C. This undiluted solution was produced at the same process as an example 1 using the core liquid which consists of the dimethylacetamide 60 section, and the module was created. As for 1054 ml/hr/m2/mmHg and albumin permeability, permeable ability showed 2% or more of very high value.

Although the 350mm dry zone of discharge, the temperature of 40 degrees C, and 100% of relative humidity was passed and the hollow fiber was produced using the same undiluted solution as example of comparison 3 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.

Although the 350mm dry zone of discharge, the temperature of 5 degrees C, and 100% of relative humidity was passed and the hollow fiber was produced using the same undiluted

solution as example of comparison 4 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.
Although the 350mm dry zone of discharge, the temperature of 30 degrees C, and 50% of relative humidity was passed and the hollow fiber was produced using the same undiluted solution as example of comparison 5 example 1, and core liquid, the compact layer was made to the polysulfone outside surface.

[Translation done.]